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Life Cycle Assessment as Decision Support Tool for Development of a Ressource Recovery Technology

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1. INTRODUCTION

Current research promotes resource recovery through different technologies:

- Physic-chemical processes: metal salt addition for phosphorus precipitation [1]
- Biological processes: optimal green microalgal cultivation (TRENS) [2]

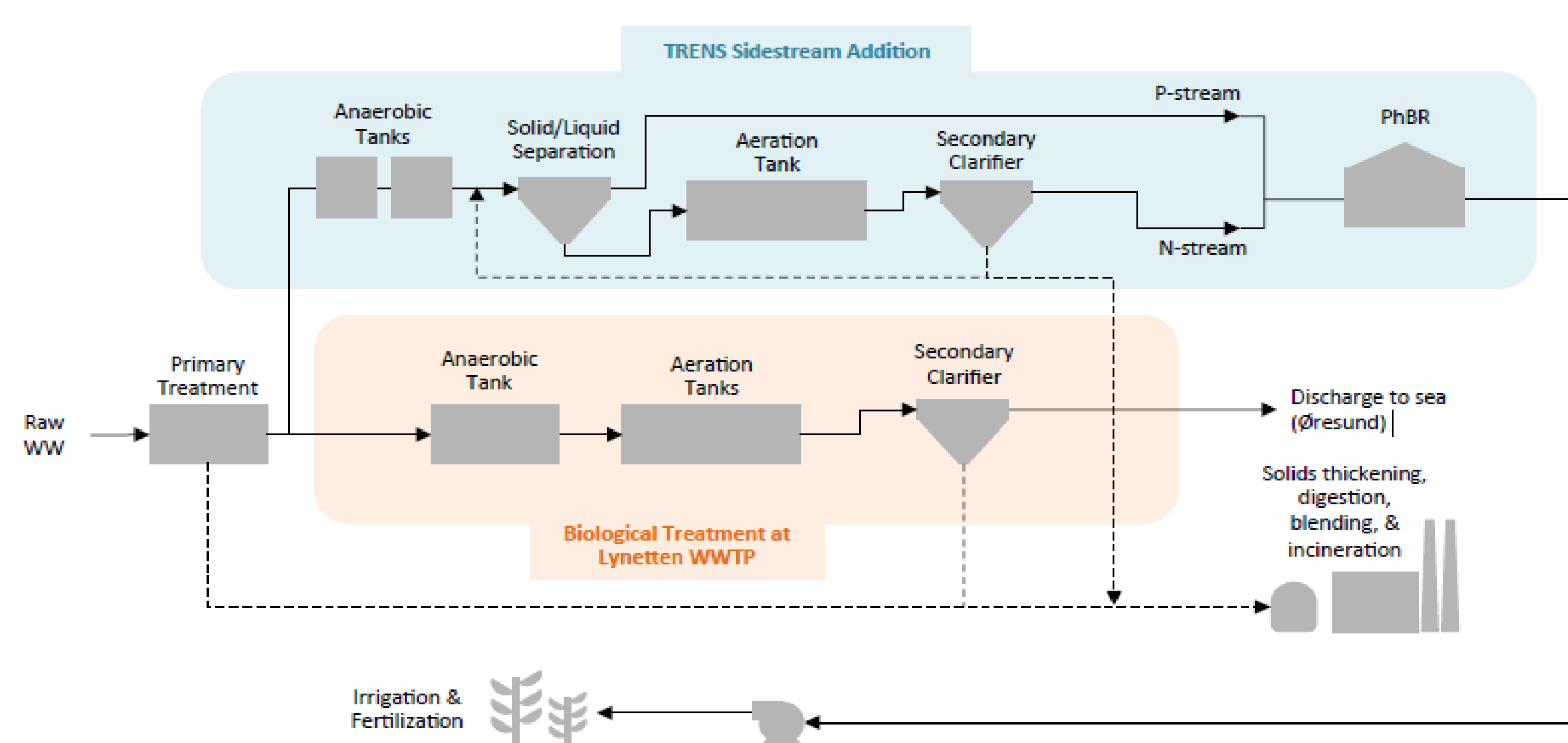
What is the environmental impact of these emerging technologies?

Objectives:

- 1) To use Life Cycle Assessment to assess the environmental impact of a resource recovery technology.
- 2) To use Life Cycle Assessment as a support tool for process design for the TRENS developers.

3. RESULTS: FERTIGATION SCENARIO

TRENS system flow diagram [2]



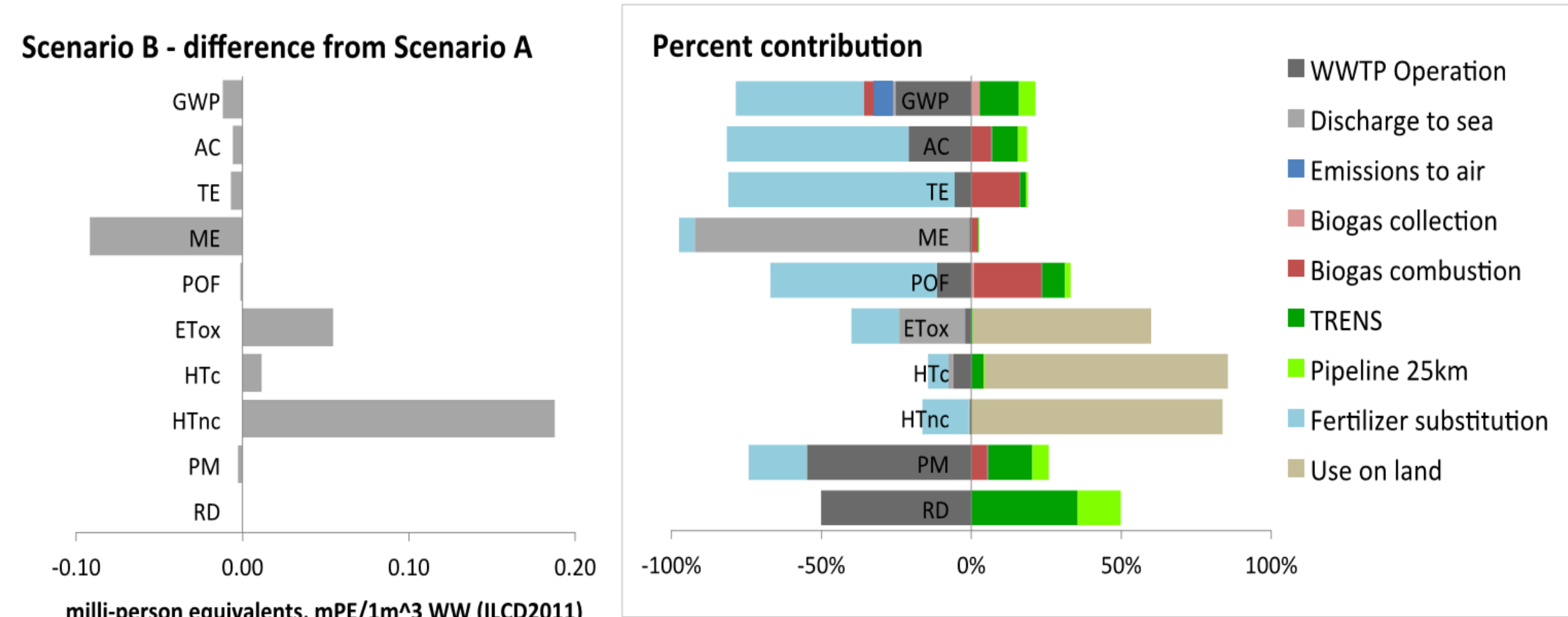
Scenario Description

TRENS system implemented as a side-stream process of Lynetten WWTP:

- System boundaries: **from the influent** to the treatment plant **to the final end use**, including the WWTP, side-stream TRENS and pressurized pipeline.
- **10% of the influent** is diverted **through the TRENS side-stream** process to accomplish with the irrigation demand by farmers in the region.
- **Lynetten** is a **large and centralized WWTP** which environmental impacts are consistent with literature.

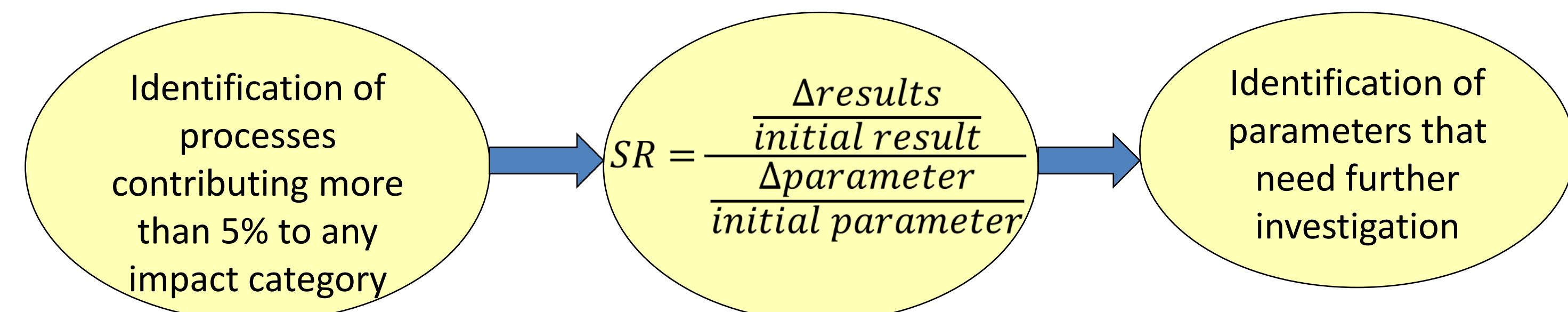
Impact Assessment

- **Small changes** on the environmental impact due to the design of a **side-stream system** (0-0.2 mPE/m³)
- **Use on land** plays a large part in the **toxicity impacts**
- **Reduced impacts:**
 - Reduced flow through the secondary treatment of WWTP: **less N₂O emissions** (-15% GWP) and **nitrate discharge** to the sea (-9% ME)
 - Offset of mineral fertilizer production
- **Increased impacts:**
 - **Land application** of the algal suspension: **heavy metals disposal** on land (+290% in HTnc)
 - **Energy consumption** of the TRENS system and pressurized pipeline
 - **Emissions from increased biogas combustion**

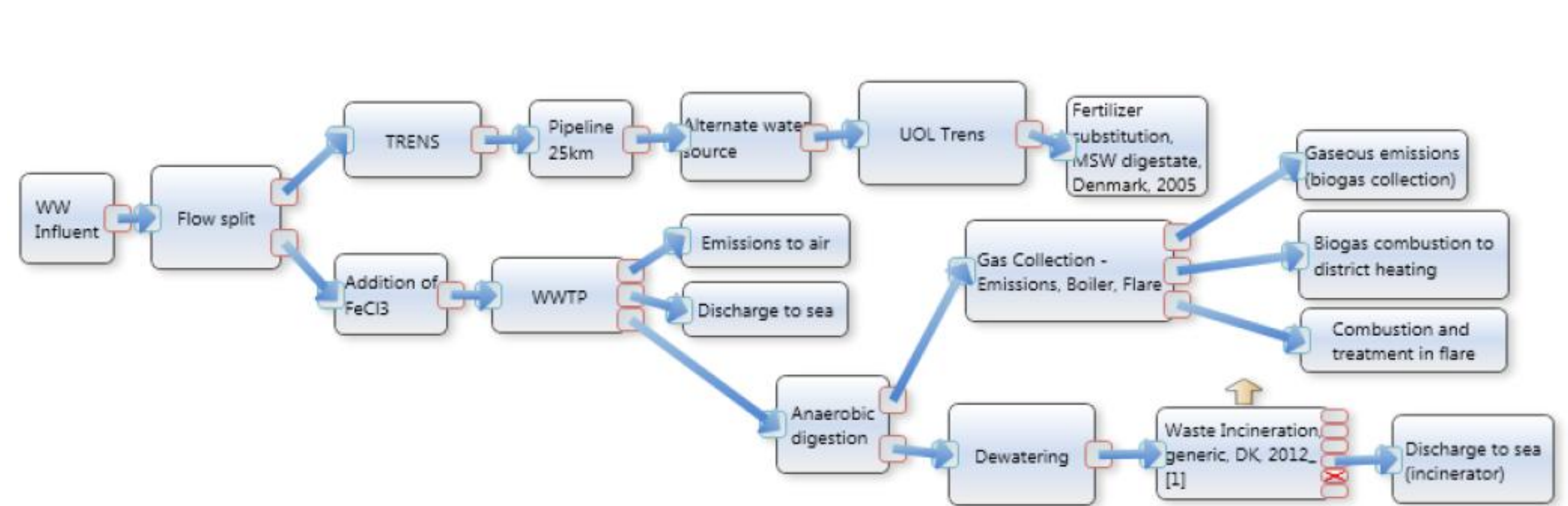


2. LCA METHODOLOGY

- **Goal and scope:** quantify environmental impact of wastewater resource recovery for fertigation using TRENS in Copenhagen. *Functional unit:* 1m³ of influent wastewater
- **Life cycle inventory:** operating reports for existing processes, databases and modeling studies using ASM-2d [3] for activated sludge processes and ASM-A [4] for algal-based processes.
- **Impact assessment:** International Reference Life Cycle Data System (ILCD 2011).
- **Contribution and perturbation analysis:** [5]

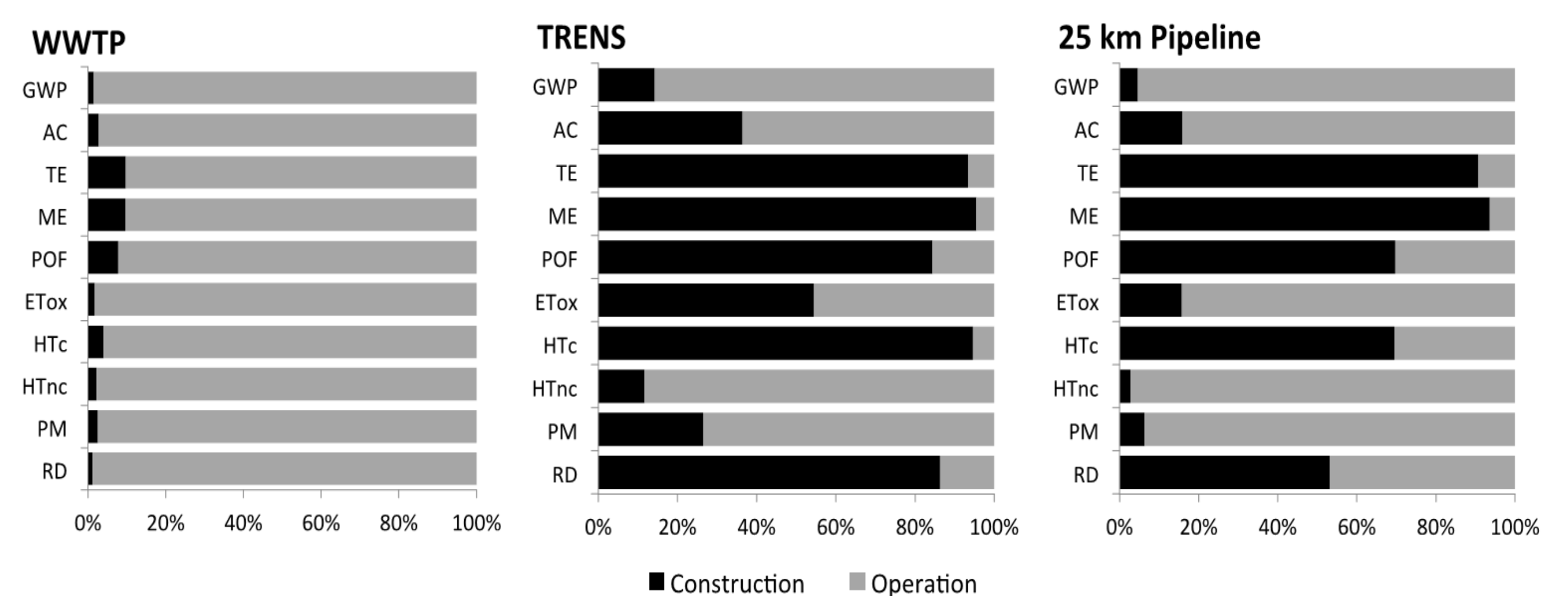


TRENS implementation in EASETECH [6]



Construction vs Operation

- **WWTP** environmental impacts driven by **operating phase**
- **TRENS system** environmental impacts driven by **construction phase**:
 - Higher use of **plastic materials** for the photobioreactor (PBR) and the pipeline
 - **Shorter service life** of the PBR



Contribution and Perturbation Analysis

- **Contribution analysis** reveals specific areas where **TRENS is competitive**, e.g. reduction of FeCl₂ by substituting chemical precipitation
- **Perturbation analysis** highlights that the **reduction in marine eutrophication** may be **lost** if the **nutrients leach** from the algae

Feedback to TRENS developers

Further research for TRENS developers should address:

- **Fate of heavy metals** in the TRENS system
- Applicability of green **microalgae** as natural **fertilizer**, paying attention to the **nitrogen mobility**
- Characterization of **N₂O emissions** in the **PBR**

4. RESULTS: AQUIFER RECHARGE SCENARIO

- **HTc impact** increases due to AlCl₃ production for pre-infiltration
- Compared to the fertigation scenario:
 - **Increased impacts** due to the **lack of nutrient recovery**: GWP, AC, TE and POF
 - **Decreased impacts** by **avoiding the disposal of heavy metals**: HT
- **Conclusion:** end use matters when developing resource recovery technologies!

ACKNOWLEDGEMENT



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References:

- [1] Verstraete, W., Van de Caveye, P. and Diamantis, V., 2009. Bioresource Technology, 100, 5537-5545
- [2] Valverde-Pérez, B., Ramin, E., Smets, B.F., and Plósz, B. Gy., 2015. Water Research, 68, 821-830
- [3] Flores-Alsina, X., Gernaey, K.V., Jeppsson, U., 2012. Water Science and Technology, 65(8), 1496-1505
- [4] Wágner, D.S., Valverde-Pérez, B., Sæbø, M., Bregua de la Sotilla, M., Van Wageningen, J., Smets, B.F., and Plósz, B.Gy., 2015. In preparation.
- [5] Clavreul, J., Guyonnet, D., and Christensen, T.H., 2012. Waste Management, 32(12), 2482-2495
- [6] Clavreul, J., Baumeister, H., Christensen, T.H., and Damgaard, A., 2014. Environmental Modeling and Software, 60, 18-30
- [7] Fang, L.L., Valverde-Pérez, B., Damgaard, A., Plósz, B.Gy., and Rygaard, M., 2015. Submitted to Water Research